BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

PATENT
PD030019

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants : Patrick Vogel and Steffen Lehr

Filed : Herewith

For : METHOD AND ELECTRONIC CIRCUIT FOR CONTROLLING OF A SUPPLY VOLTAGE OF A LASER DIODE

CLAIM OF PRIORITY UNDER 35 USC 119

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicants hereby claim the benefit of priority under 35 USC 119 and under the International Convention for the Protection of Industrial Property of EPO Application No. 03001169.6, filed January 21, 2003.

A certified copy of the priority document is enclosed.

Respectfully submitted,

PATRICK VOGEL ET AL.

By _____
Reitseng Lin
Attorney for Applicants
Reg. No. 42,804
(609) 734-6813

Patent Operations
Thomson Licensing Inc.
Two Independence Way, Suite #2
Princeton, NJ 08540

RL/kms

January 16, 2004

Europäisches Patentamt | European Patent Office | Office européen des brevets

Bescheinigung | Certificate | Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

03001169.6

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

Europäisch Patentamt | Eur pean Pat nt Offic | Offic urop n d s brev ts

Anmeldung Nr:
Application no.: 03001169.6
Demande no:

Anmeldetag:
Date of filing: 21.01.03
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

DEUTSCHE THOMSON-BRANDT GMBH
Hermann-Schwer-Strasse 3
78048 Villingen-Schwenningen
ALLEMAGNE

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Method and electronic circuit for controlling of a supply voltage of a laser diode

In Anspruch genommene Priorität(en) / Priority(ies) claimed /Priorité(s) revendiquée(s)
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/
Classification internationale des brevets:

H01S/

Am Anmeldetag benannte Vertragstaaten/Contracting states designated at date of filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LU MC NL
PT SE SI SK TR LI

PD030019*Ku

Method and lectronic circuit for controlling of a supply voltage of a las r diode

Field of the invention

The present invention generally relates to the field of controlling of light sources, and more particularly to controlling of a laser diode of an optical reader and/or recorder, such as CD or DVD players and/or recorders.

Background and prior art

Typically a laser diode is arranged in a PNP type circuit configuration or, alternatively, in an NPN type circuit configuration. The control of the supply voltage of the laser diode needs to be adapted to the type of circuit configuration which is used, otherwise the lifetime of the laser diode is reduced or the laser diode is even destroyed when the control of the power supply is initialized.

US Patent number 6,363,044 B1 shows a photo diode detection circuit which is used to automatically identify a type of photo diode circuit connected to it. Once the type of photo diode circuit has been identified by applying a current to it and evaluating a voltage occurring at an input of the detection circuit, the photo detection circuit adapts itself to it, e.g. a reverse biasing voltage is or is not applied to the photo diode of the photo diode circuit. The result is a photo diode detection circuit which uses a forward or a reversed biased photo diode. The photo diode detection circuit is now in a state to measure light falling on the photo diode. The detection circuit is used for monitoring the light intensity of a light source

and for a controlling circuit which enables to regulate the intensity of the light source. It is a disadvantage of this prior art controlling circuit that it does not automatically adapt to the circuit configuration in which the light source is arranged.

Summary of the invention

It is an object of the invention to find a solution for a control circuit and method which automatically adapts to the circuit configuration in which a laser diode is arranged.

A solution to the above described problem is provided by applying the features laid down in the respective independent claims. Preferred embodiments of the invention are given in the dependent claims.

The invention enables an effective protection of a light source, such as a laser diode, against application of a wrong supply voltage. It is a particular advantage of the present invention that this accomplished without a need for an extra control pin and without inputting of control information indicating the kind of circuit configuration of the laser diode. Rather the present invention enables to automatically detect the circuit configuration of the laser diode and to initialize the control of the power supply for the laser diode correspondingly.

The present invention is advantageously employed for optical readers and/or recorders such as CD and/or DVD readers and/or recorders.

Brief description of the drawings

In the following preferred embodiments of the invention will be described in greater detail by making reference to the drawings in which:

Figure 1 shows a block diagram of an embodiment of an electronic circuit of the invention,

Figure 2 shows a detailed view on the module of figure 1 generating the OUTPOL signal,

Figure 3 is an alternative embodiment of the circuit of figure 2,

Figure 4 is illustrative of a signal diagram when the output stage is of the PNP type,

Figure 5 is illustrative of a signal diagram when the output stage is of the NPN type,

Figure 6 shows an alternative embodiment of the circuit of figure 1 having an additional detector for the polarity of the measurement signal,

Figure 7 to figure 10 are illustrative of signal diagrams of the preferred embodiment of figure 6

Detailed description

Figure 1 shows a control circuit 100 having a comparator 102. The comparator 102 has input switches S11, S12, S13 and S14 which determine the output polarity of the comparator 102. The input voltage at pin IN of the comparator 102 is compared with an adjustable reference voltage Vref1.

Further control circuit 100 has an active off circuitry 104, which comprises two current sources Iu Id as well as switches S31 and S32.

A safety block 106 is coupled to the control circuit 100. The safety block 106 decides when the laser control switches from the active off phase into the start up phase. The safety block 106 generates an ENABLE signal when the command ON is applied and if the start up condition (external capacitors are de-charged) are fulfilled.

Further there is a safety block 108 which is coupled to the control circuit 100. Safety block 108 serves to determine whether the laser diode which is controlled by the control circuit 100 is in a PNP type or an NPN type circuit configuration. Preferred implementations of safety block 108 are illustrated in figures 2 and 3.

A PNP type circuit configuration 110 having a laser diode 112 or alternatively an NPN type circuit configuration 114 comprising laser diode 116 is connected to the output OUT of control circuit 100. The PNP type circuit configuration 110 is a driver circuit for the laser diode 112 using an PNP transistor type. Likewise the NPN type circuit configuration 114 is a driver circuit for laser diode 116 using an NPN transistor type.

A measurement photo diode 118 is connected to the input IN of the control circuit 100. The photo diode 118 measures the light emission of the laser diode 112 or laser diode 116, respectively. This way a feedback signal is provided to control circuit 100 which forms the basis for controlling the supply voltage for laser diode 112, or laser diode 116.

The voltage control of the control circuit 100 is adapted by the OUTPOL signal delivered by the safety block 108 depending whether PNP type circuit configuration 110 or NPN type circuit configuration 114 is connected to the output OUT of control circuit 100. In particular the polarity of the comparator 102 and also the active OFF circuitry 104 is adapted accordingly depending on the OUTPOL signal. The operation of the control circuit 100 has several operation modes:

- active OFF

The external capacitance of the PNP type circuit configuration 110 or the NPN type circuit configuration 114 is de-charged, so that the laser diode 112 or 116, respectively is OFF. This is a safety requirement in order to avoid destruction of the expensive laser diodes 112 or 116.

- active ON

The laser control is switched off when the start up phase is entered. During the start up phase safety functions are checked and the external capacitors are charged.

- control phase

When all safety checks have been fulfilled the control circuit 100 enters the control phase. The laser diode light emission is regulated based on the reference voltage Vref1.

Figure 2 is illustrative of an implementation of the safety block 108. Figure 3 is illustrative of an alternative implementation of the safety block 108 which is preferred to the implementation of figure 2. The INIT block generates a pulse of about 100 nanoseconds pulse length when the supply voltage has reached its nominal value.

With this pulse the OUTPOL signal is set to a default setting. For example the default setting is OUTPOL = 1 which means that the PNP type circuit configuration 110 (cf. figure 1) is the default circuit configuration. Alternatively the NPN type circuit configuration 114 can be chosen as a default configuration.

Figure 4 is illustrative of the initialization of the control of the supply voltage depending on the type of circuit configuration. In the embodiment of figures 4 and 5, it is assumed that the default setting is OUTPOL = 1, which means that PNP type circuit configuration 110 is the default circuit configuration.

Figure 4 shows the signal diagram if the circuit configuration of the laser diode is indeed of the PNP type circuit configuration 110.

During the active OFF phase the supply voltage at the output OUT is gradually increased towards the reference voltage Vrefpnp of the PNP type circuit configuration 110 (cf. Fig. 1). At the same time the measurement signal applied at the input IN is monitored. As the measurement signal applied at the input IN does not show a peak this means that the assumption that the laser diode is in the PNP type circuit configuration 110 is correct and that the polarity of the signal OUTPOL does not need to be changed from the default setting. After the active OFF and the start up phase, the control operation for controlling the supply voltage starts.

Figure 5 shows a corresponding signal diagram when the output circuit configuration is not the default PNP type circuit configuration but an NPN type circuit configuration. Again the supply voltage at the output OUT of the control circuit is gradually increased towards the

reference voltage VREFPNP of the PNP type circuit configuration 110 as the PNP type circuit configuration is the assumed configuration. As the laser diode is in fact arranged in an NPN type circuit configuration application of the gradually increasing supply voltage results in the emission of light from the laser diode and thus in a peak 120 of the measurement signal applied at the input IN.

In response to the peak 120 the polarity of the OUTPOL signal is changed from 1 to 0 and the direction of change of the supply voltage signal at the output OUT is likewise changed into the direction of the voltage reference Vrefnpn of NPN type circuit configuration 114.

Figure 6 shows a block diagram of an extended embodiment based on the embodiment of figure 1. In the embodiment of figure 6 there is photo diode detection circuit 122 between the input IN and the input of control circuit 100. Preferably photo diode detection circuit 122 is designed in accordance with US patent number 6,363,044B1, which is incorporated herein by reference in its entirety.

Due to the photo diode detection circuit 122 it is possible to either use photo diode 118 or reverse biased photo diode 124. In either case the photo diode detection circuit 122 will deliver the same signal INCOMP for inputting into the comparator 102 of the control circuit 100 (cf. figure 1).

As apparent from the signal diagrams of figures 7 to 10, the operation of the control circuit 100 is the same irrespective of whether photo diode 118 or photo diode 124 is used. Figure 7 shows the signal diagram where the laser diode is arranged in the default PNP type circuit configuration and diode 118 is used. Figure 8 shows the

situation where diode 124 is used. In this instance the polarity of the INPOL signal is changed, such that switch S5 of photo diode detection circuit 122 (cf. figure 6) is switched from its '1' to its '0' position.

Figures 9 and 10 show the corresponding signal diagrams for a laser diode being arrange in an NPN type circuit configuration.

Claims

1. A method for initialising a control of a supply voltage of a light source, such as a laser diode, the light source being arranged in a first circuit configuration having an associated first reference voltage level or the light source being arranged in an alternative second circuit configuration having an associated alternative second reference voltage level, the method comprising the steps of:

   - gradually changing the supply voltage into the direction of the first reference voltage,

   - measuring a light emission of the light source while gradually changing the supply voltage,

   - if no light emission is measured: starting the control of the supply voltage of the light source after the first reference voltage has been reached,

   - if a light emission is measured: gradually changing the supply voltage into the direction of the second reference voltage and starting the control of the supply voltage of the light source after the second reference voltage has been reached.

2. The method of claim 1, the first circuit configuration being an NPN type circuit configuration and the second circuit configuration being an NPN type circuit configuration.

3. The method of claim 1 or 2, whereby the light emission of the light source is measured by means of a photodiode.

4. The method of claim 1, 2 or 3, further comprising detecting of a polarity of the measurement of the light emission of the laser diode.

5. An electronic circuit for controlling a supply voltage of a light source, such as a laser diode (112, 116), the light source being arranged in a first circuit configuration (110) having an associated first reference voltage level, or the light source being arranged in alternative second circuit configuration (114) having an associated alternative second reference voltage level, the electronic circuit comprising:

- means (100) for gradually changing the supply voltage into the direction of the first reference voltage for initialising the control of the supply voltage,

- means (118; 124) for detecting of a light emission of the laser diode,

- means (100) for gradually changing the supply voltage into the direction of the second reference voltage, if a light emission of the laser diode is detected while the supply voltage is gradually changed into the direction of the first reference voltage.

6. The electronic circuit of claim 5, whereby the first circuit configuration is of an PNP type and the second circuit configuration is of an NPN type.

7. The electronic circuit of claims 5 or 6, the means for detecting a light emission comprising a laser diode.

8. The electronic circuit of claims 5, 6 or 7, further comprising means (122) for detecting of a polarity of a

measurement signal provided by the means for detecting of a light emission.

9. An optical reader and/or recorder comprising a laser diode and an electronic circuit for controlling of a supply voltage of the laser diode in accordance with any one of the proceeding claims 5 to 8.

Abstract

Method and el ctronic circuit for controlling of a supply voltage of a laser diode

The invention relates to a method for initialising a control of a supply voltage of a light source, such as a laser diode, the light source being arranged in a first circuit configuration having an associated first reference voltage level or the light source being arranged in an alternative second circuit configuration having an associated alternative second reference voltage level, the method comprising the steps of:

- gradually changing the supply voltage into the direction of the first reference voltage,
- measuring a light emission of the light source while gradually changing the supply voltage,
- if no light emission is measured: starting the control of the supply voltage of the light source after the first reference voltage has been reached,
- if a light emission is measured: gradually changing the supply voltage into the direction of the second reference voltage and starting the control of the supply voltage of the light source after the second reference voltage has been reached.

(Figure 1)

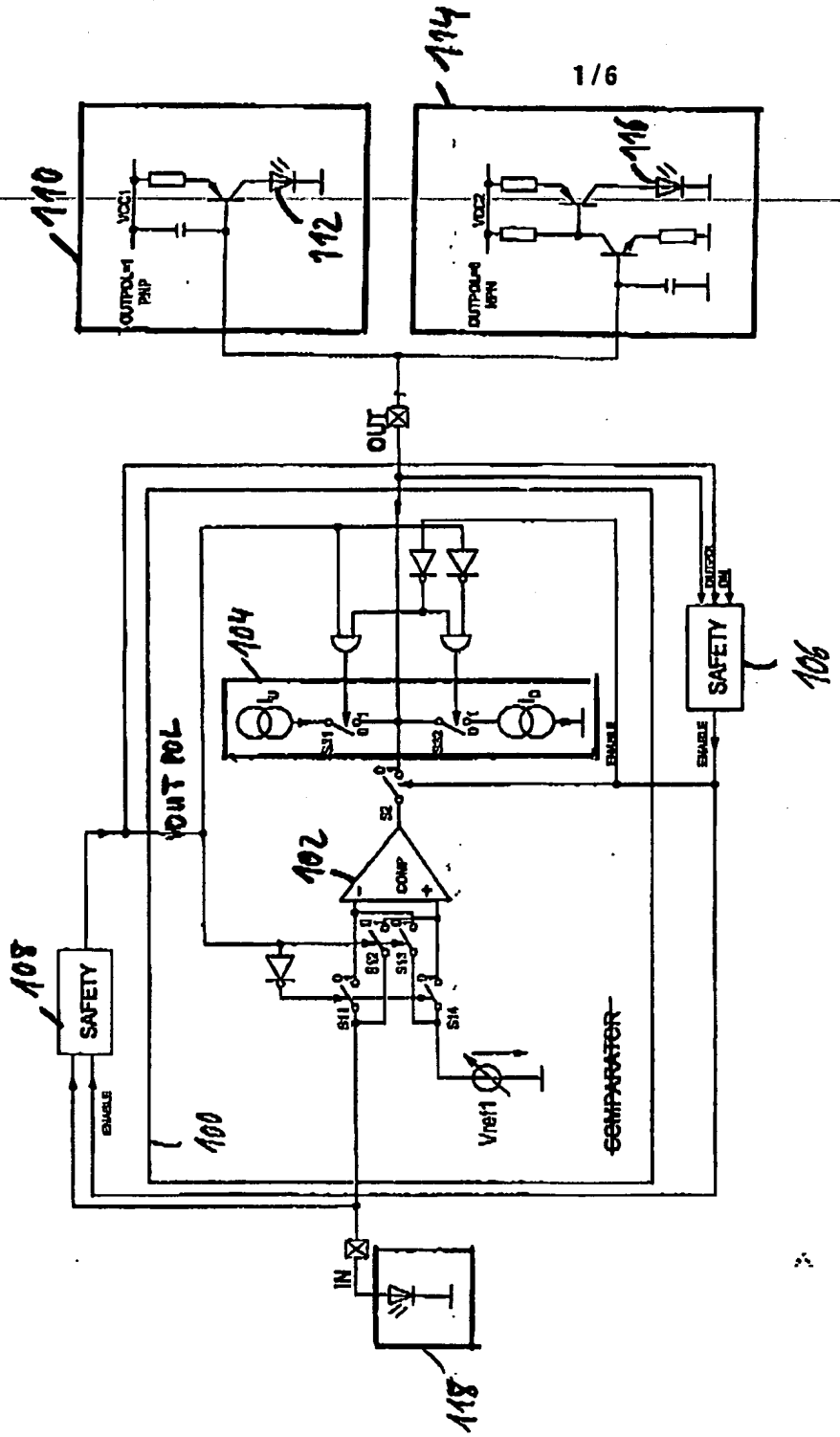
110
112
114
116
OUTPOL=1 PMP
OUTPOL=0 NMN
VCC1
VCC2
OUT
104
102
106
108
100
SAFETY
COMP
COMPARATOR
OUTPOL
ENABLE
IN
118
Vref1
S11
S12
S13
S14

Fig. 1

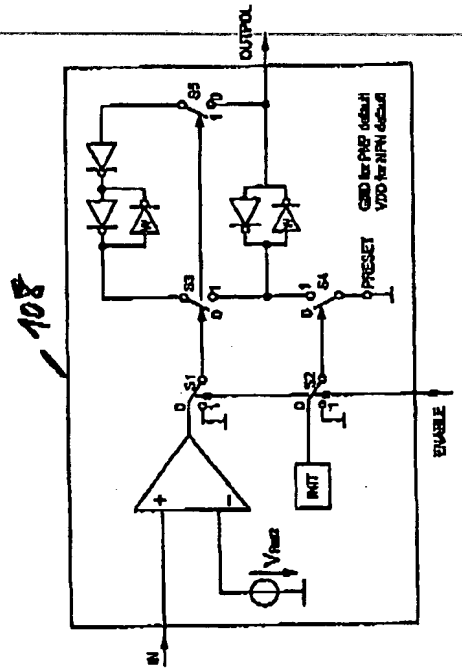

Fig.3

DETAIL OUTPOL

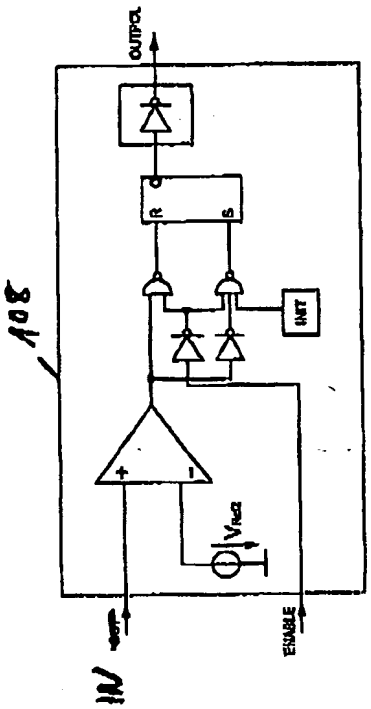

Fig.2

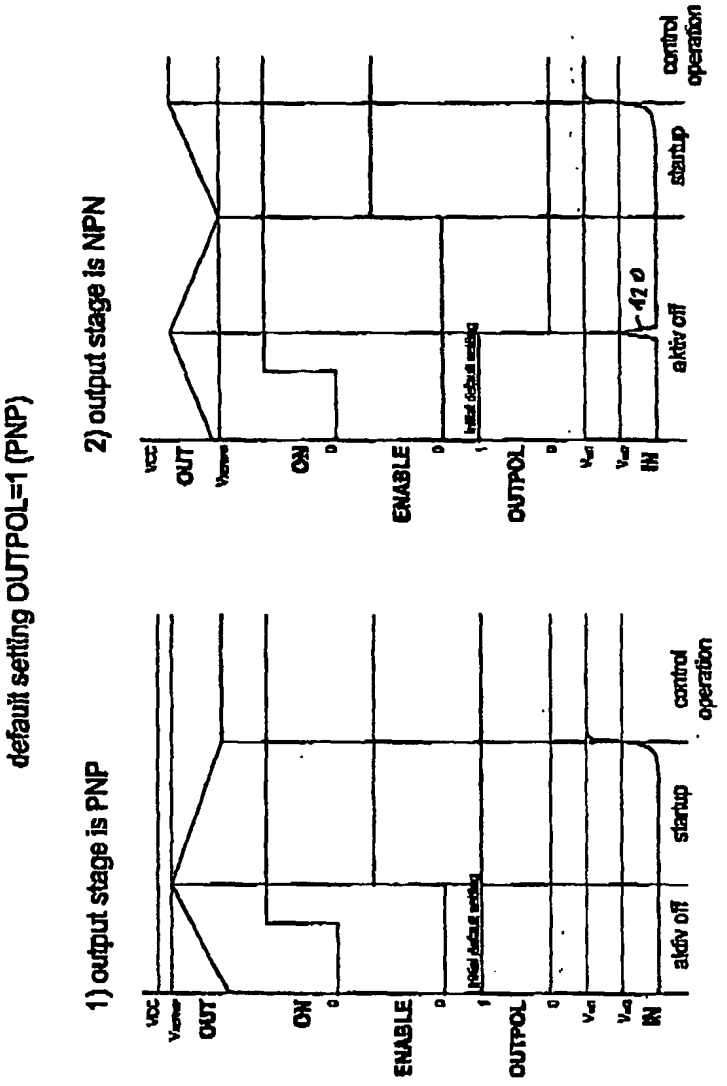
default setting OUTPOL=1 (PNP)
1) output stage is PNP
2) output stage is NPN
VCC
OUT
ON
ENABLE
OUTPOL
IN
aktiv off
startup
control operation
initial default setting
420

Fig. 4

Fig. 5

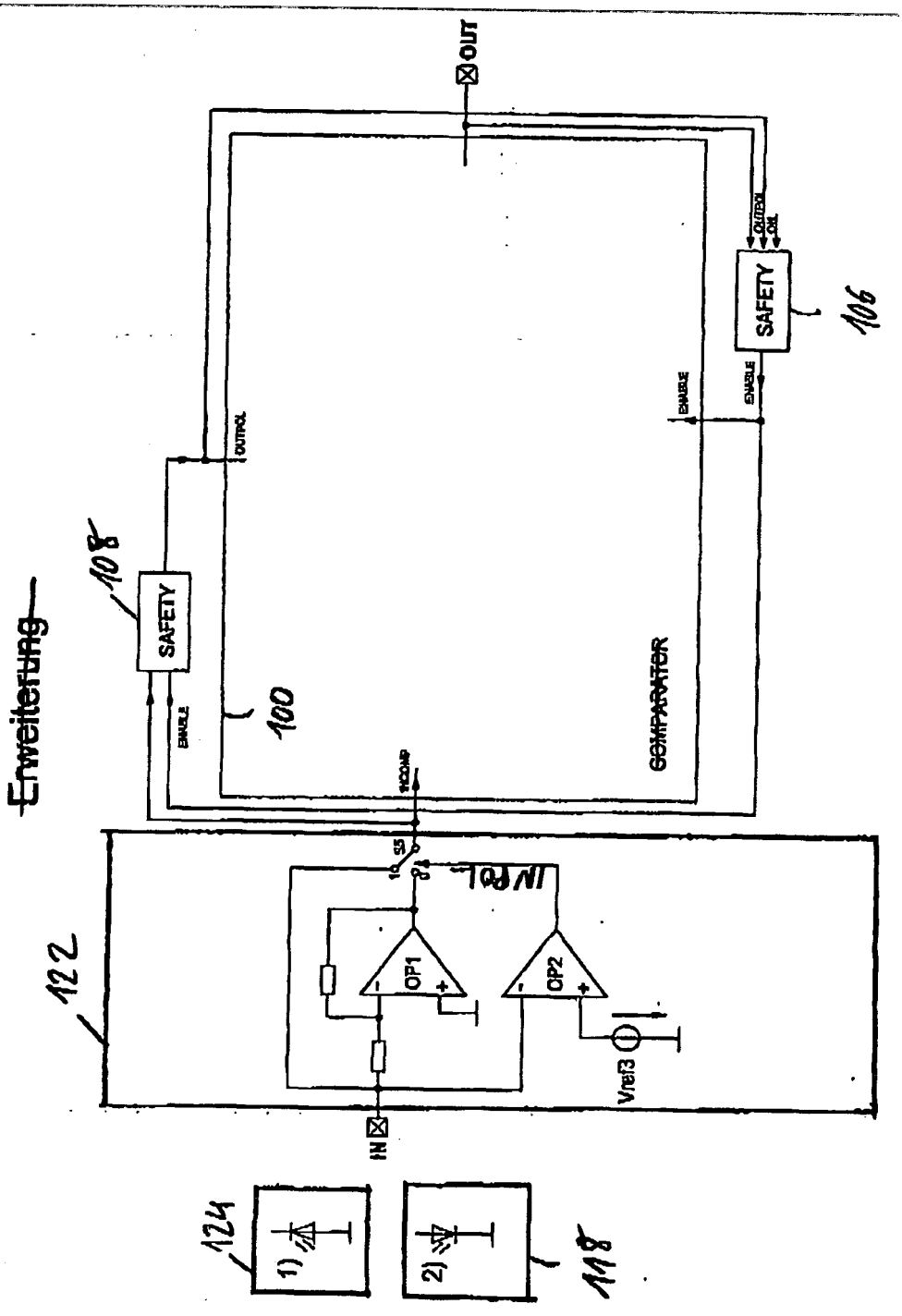
OUT
SAFETY
106
OUTPUT
ENABLE
ENABLE
CONTROL
SAFETY
108
100
COMPARATOR
Erweiterung
122
OP1
OP2
Vref3
IN
124
1)
2)
118

Fig 6

~~Erweiterung 1~~
default setting OUTPOL=1 (PNP)

3) PNP outputstage pos. IN polarity

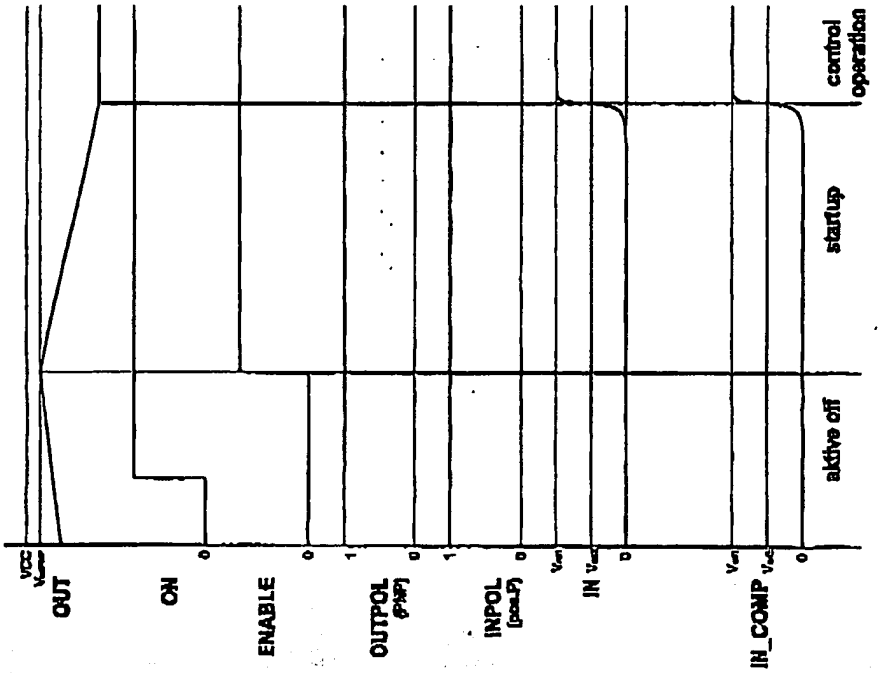

Fig. 7

4) PNP outputstage neg. IN polarity

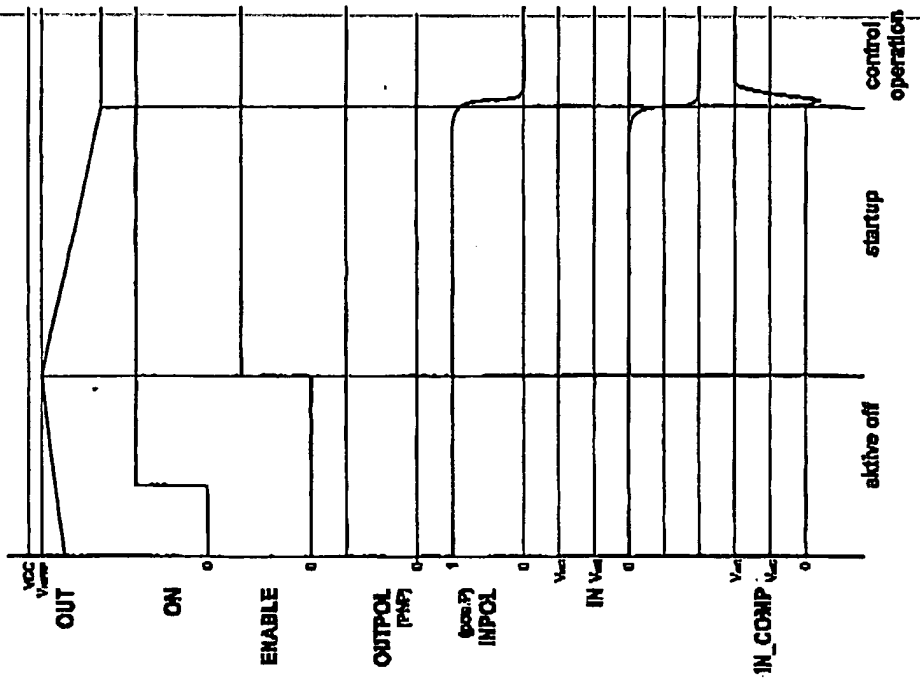

Fig. 8

Erweiterung 2)

default setting OUTPOL=1 (PNP)

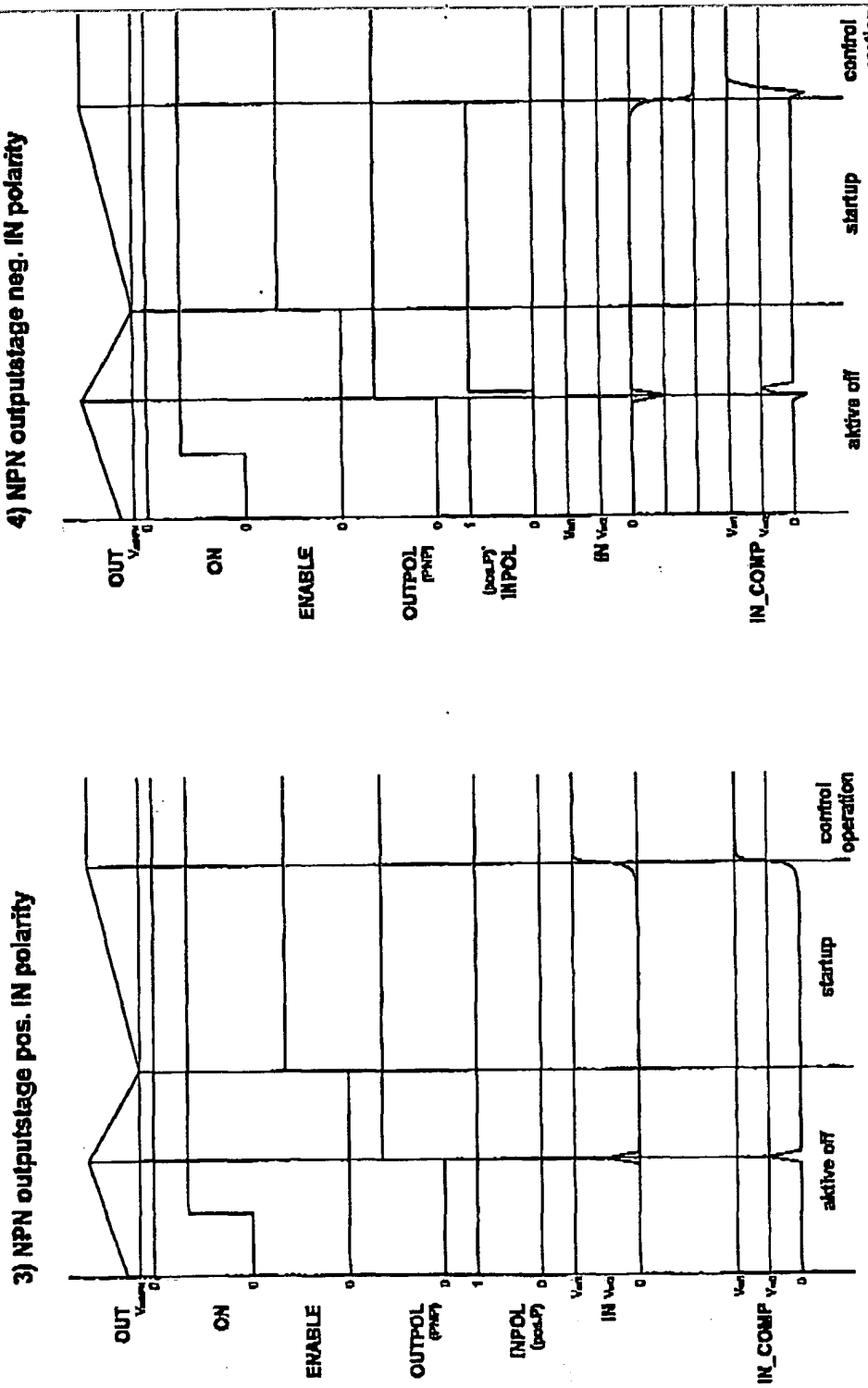

Fig. 9

Fig. 10